PRODUCT REALIZATION: DESIGN AND MANUFACTURING

Course Objectives

The course aims to:

1. Introduce students to the complete product realisation cycle from concept generation to manufacturing.
2. Develop skills in product design, engineering analysis, material selection, and manufacturing planning.
3. Familiarize students with modern manufacturing technologies and rapid prototyping techniques.
4. Enable students to integrate design, simulation, and manufacturing considerations for industrial product development.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

CO1: Understand the product development and realisation process.
CO2: Apply engineering design principles for product development.
CO3: Select appropriate materials and manufacturing processes.
CO4: Use CAD/CAE tools for digital product development.
CO5: Develop prototypes using modern manufacturing technologies.

Module I: Introduction to Product Realisation and Design Process (6 Hours)

Concepts of product life cycle management (PLM), role of design and manufacturing in product development, requirement analysis, customer need identification, design thinking approach, problem definition, opportunity mapping, functional decomposition, product architecture, concept generation, concept evaluation, and preparation of engineering specifications.

Module II: Engineering Design Methodology (8 Hours)

Design constraints, performance requirements, concept selection methods, morphological analysis, design optimization, design for manufacturability (DFM), design for assembly (DFA), design for reliability, and design for sustainability.

Material selection strategies, ergonomic considerations, aesthetics in product development, value engineering, and cost optimization techniques.

Module III: Computer-Aided Product Development (8 Hours)

Computer-aided design (CAD), parametric and feature-based modelling, assembly modelling, tolerance analysis, and digital product development. Introduction to computer-aided engineering (CAE), finite element analysis (FEA) for structural and thermal evaluation, computational fluid dynamics (CFD) applications in product development, virtual prototyping, and design optimization techniques.

Module IV: Manufacturing and Prototyping Technologies (8 Hours)

Selection of appropriate manufacturing processes, conventional manufacturing techniques such as casting, forming, machining, and joining processes. Advanced manufacturing methods including additive manufacturing, rapid prototyping, CNC manufacturing, and laser-based manufacturing techniques.

Materials used in additive manufacturing, prototype development, testing, reverse engineering, and the importance of manufacturing considerations during product design.

Module V: Product Realisation and Industrial Applications (6 Hours)

Design verification and validation, quality considerations, manufacturing cost estimation, production planning, supply chain aspects, and sustainable product development.

Industry 4.0 concepts including smart manufacturing, digital twins, Internet of Things (IoT)-enabled production systems, automation, and robotics.

Case studies related to automotive components, biomedical devices, renewable energy systems, and consumer products.

Text Books

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw Hill.
2. George E. Dieter and Linda Schmidt, Engineering Design, McGraw Hill.

3. Mikell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson.
4. S. Kalpakjian and S. Schmid, Manufacturing Engineering and Technology, Pearson.

Reference Books

1. Pahl and Beitz, Engineering Design: A Systematic Approach.
2. Ian Gibson, David Rosen & Brent Stucker, Additive Manufacturing Technologies.
3. A. K. Chitale and R. C. Gupta, Product Design and Manufacturing.